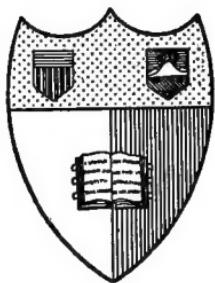


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Teff Grass

(*Eragrostis abyssinica*)

A valuable hay and pasture grass
for arid and semi-arid
tropical and warm-
temperate
regions.

BY

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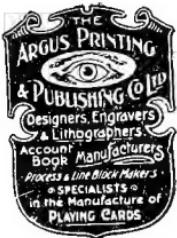


“*No grass no cattle, no cattle no manure,*
No manure no crops”—Belgian Proverb.



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DEDICATED
TO
THE FARMERS OF SOUTH AFRICA

in cordial appreciation of their many courtesies and
their generous and sympathetic support of the
Author's agricultural investigations during his ten
years of service as Government Agrostologist and
Botanist in the Transvaal and Union Departments
of Agriculture.

AUTHOR'S NOTE.

This little volume has been published with the proceeds of the fund subscribed by the Farmers of South Africa for the "Burtt-Davy Testimonial," indicating their appreciation of the value of Teff. A copy is being supplied to each subscriber whose name and address is known.

Teff Grass.

(*Eragrostis abyssinica*.)

PART I.—USES AND VALUE OF TEFF.

It was sometime between 1768 and 1773, almost one hundred and fifty years ago, that the traveller, Bruce, found the native Abyssinians cultivating Teff as a cereal food-stuff. But it was not till one hundred and twenty years later that this valuable grass was introduced into cultivation in other parts of the world. Just thirty years ago (1886), the Royal Botanic Gardens, Kew, obtained teff seed from Abyssinia and distributed it to numerous Botanical Gardens and Agricultural Experiment Stations in India and the British Colonies (3)*.

It is the exception when the introduction of a new crop produces spectacular results, but Teff is one of those rare exceptions. Within seven years of its introduction into South Africa it not only put scores of struggling farmers well on their feet, but they have publicly stated that its introduction has repaid the State over and over again for the whole cost of the Division of Botany of the Department of Agriculture, since the latter was started.

Briefly, its history is as follows: Teff has been cultivated for centuries by the Abyssinians as a quick-growing, drought-resistant, heavy-yielding grain crop. Because of these qualities seed was introduced into India in 1886, with a view to providing a grain-crop in times of low rainfall, resulting in famine. For this purpose it did not prove a success, since the Oriental does not take readily to new food-stuffs. It was favourably reported upon, however, as a fodder-grass, not only in India, but also in Australia and Natal, where it had been introduced at the same time; but in none of these countries did it acquire the status of a farm crop; it was merely tried and allowed to disappear. About the year 1895, when in charge of the botanical experiments of the California State Agricultural Experiment Station, I introduced Teff to the Experiment Station at Berkeley. But California being a region of winter rainfall, where Lucerne was the staple fodder, farmers had little use for an annual hay-crop, and Teff never attracted much attention. However, in May, 1903, I brought seed with me from California to South Africa. The first seed from this introduction was harvested in the early part of 1904. The Transvaal being a region of summer rainfall, with a climate very similar to that of the South-eastern United States, Teff grew splendidly, and soon began to attract attention. In the season 1904-05, Mr. V. L. Robertson, of Amersfoort, to whom I supplied seed for trial, reported most highly upon it. In the season 1905-06, twenty out of twenty-two farmers who tried it, found it an unqualified success. In 1906-07, twenty-one out of twenty-eight were successful. Then farmers began to

* The numbers in brackets refer to the Bibliography at the end.

sell seed to one another, and for several years the demand for seed always exceeded the supply. In the year 1911 I had offers of seed totalling 50 tons weight—grown from the half pound of seed brought from California.

DESCRIPTION.

○ Teff (*Eragrostis abyssinica*) is an annual grass, characterised by its leafiness and fineness of stem, heavy seeding capacity, rapid growth, early maturity, and its resistance to drought and heat. It grows 2½ to 4 ft. high, branches freely from the base, produces abundance of seed-heads and a heavy crop of very small, hard grain, which, in the variety cultivated here, is dark brown in colour. When cut above the ground, the teff-plant throws out fresh branches from the base of the cut stems; in this way second and third crops of hay can be obtained in favourable seasons. It is one of the quickest-growing crops known, being ready to cut for hay in six to eight weeks from sowing, and ripening seed in eight to twelve weeks.

DROUGHT-RESISTANCE.

Though the seedlings are so fine in texture as to appear delicate, they are not readily scorched by the hot summer sun, which is an important point in this climate. The plant is sensitive to frost, but as it “cures on the root” (in cowboy parlance), this is not a serious drawback.

As a farm crop, Teff is drought-resistant, though some farmers claim that this is not the case. Drought-resistance is a relative quality, and as compared with most of our crops, Teff is extraordinarily drought-resistant. Reports from the Bloemfontein district state that a crop of Teff hay has been grown on a four-inch rainfall. Mr. J. J. van Rensburg, Leeuwdoorns, reported that after sowing Teff, on December 5th, 1910, followed by a heavy rain next day, the crop had no more rain till March 8th, yet a good crop was harvested on April 29th.

Reports of Australian experiments stated that one of the chief merits of Teff was “its suitability to thrive in dry, sandy regions where few other grasses would flourish equally well.” (10.)

USES.

In its native country Teff is cultivated as a cereal crop for bread, and for the preparation of a kind of beer. In South Africa it is grown chiefly as a hay-crop; but also for pasturage, green-manuring, silage, and as a “smother crop” for cleaning land foul with weeds.

The chief value of Teff-hay lies in its palatability, high nutritive value, narrow albuminoid ratio (for a grass hay), heavy yield, rapid growth, drought-resistance, and ability to smother weeds. Our experience with Teff in the Transvaal is that if sown in October (provided we have moderately good rains to establish the baird) we can obtain a cutting of about a ton of hay per acre by the beginning of the new year; at this time we often have ten days to two or three weeks free from rain, which allows farmers to harvest the crop nicely. Our steady rains usually begin about the middle of January; these induce the Teff to start fresh growth,



Teff (*Eragrostis abyssinica*).
From a drawing by Mrs. Burtt-Davy.

which continues till the dry weather begins in March ; by this time another hay crop of one to one-and-a-half tons per acre can be cut and cured. Light showers usually occur in March, enabling the Teff crop to make an after-math which furnishes good pasturage, even after it has been killed by frost. If weather, etc., do not permit us to sow in October we can sow through January and still secure a good crop.

As compared with Sweet-grass (*Chloris virgata*) hay, the more rapid growth, heavier crop per acre, and the possibility of cutting three times in a season, put Teff ahead of Sweet-grass.

As a hay-grass for India Mr. Duthie considered that Teff is "destined to become the rye-grass of India, and is well worthy of more extended trial on some of the Government fodder reserves." (8 and 10.)

In Australia very favourable reports on trials with Teff were given, "the value of this plant for fodder purposes being considered exceptionally high." (10.)

The high-feeding value of Teff hay is due in measure to the large amount and nutritive value of the seed contained, and in part to the fact that the hay is fine in texture, and, therefore, easily and quickly cured if the weather is at all favourable.

PALATABILITY.

A very important feature in favour of Teff as a stock food is the eagerness with which farm livestock of all kinds seek it out. "Cattle, horses, sheep and pigs devour it eagerly. Several breeders of blood horses have written me that they find it excellent for young stock. A friend of mine, farming near Britten, declares that his cattle will leave green lucerne for it, and I have a letter from a prominent dairyman in the Witwatersrand district who avers that his milk supply was increased at least 5 per cent. by feeding his cows on Teff." (19.) Cows and oxen will leave their maize stalks and silage for Teff-hay.

Mr. J. F. Duthie reported, in 1888 (8), that at one of the hill stations of India (Arnigadh) the hay made from Teff "was greedily eaten by the garden bullocks. When it was offered to them they were being fed upon jowar (i.e., Kaffir-corn) or sorghum stalks, and, as is well known, these are remarkably sweet, and cattle, when fed upon them, generally refuse other kinds of dry food until they find that sorghum is not forthcoming. Our garden cattle, however, seemed to prefer the Teff-hay to sorghum, as they would not touch the latter until they had devoured the whole of the Teff placed before them."

ANALYSIS OF THE HAY.

Analyses of Teff-hay were made by Mr. Herbert Ingle, F.I.C., F.C.S., Chief Chemist of the Transvaal Department of Agriculture, in the year 1906-07. These show that good Teff-hay is richer in protein (flesh-forming matter) than oat-hay or Boer manna hay, and that the albuminoid ratio is much better balanced than in either. But over-ripe, thrashed hay, may be deficient in protein as compared with either oat-hay or Boer manna. There is less fat in Teff-hay than in oat-hay.

The following comparison is made from the figures supplied in Mr. Ingle's report (17):—

	Teff-hay.		Oat-hay.		Boer manna.		Lucerne hay.	
	A	B			A	B		
Moisture	8.88	9.16	8.00		8.25	6.54	7.97	
Ash	5.55	6.71	4.23		7.78	6.06	8.94	
Protein	6.21	4.72	5.65		5.00	4.90	15.49	
Soluble carbohydrates	39.08	42.71	44.04		46.24	38.93	30.58	
Ether extract	1.21	1.07	3.87		1.88	1.07	2.36	
Crude fibre	39.07	35.63	34.22		30.85	42.50	34.76	
	100.00	100.00	100.01		100.00	100.00	100.10	
Albuminoid ratio—								
Conventional	1 : 6.8	1 : 9.6	1 : 9.4	1 : 10.1	1 : 8.5	1 : 2.3		
Suggested by Mr. Ingle	1 : 12.8	1 : 16.8	1 : 14.5	1 : 15.8	1 : 16.8	1 : 4.4		
Analysis of the Ash—								
Silica	3.25	4.08	2.01	5.67	2.44	0.49		
Potash	1.28	1.62	—	—	2.30	3.61		
Lime	0.30	0.27	0.18	0.30	0.21	1.38		
Phosphorus pentoxide	0.24	0.28	0.34	0.32	0.09	0.32		
Ratio of lime to 100 phosphorus pentoxide	125	96	53	94	217	431		

OPINIONS OF PRACTICAL FEEDERS.

The following questions were submitted to three South African farmers who use Teff: (1) Mr. W. M. Struben, Charlestown, Natal; (2) Mr. W. Gillespie, Zandspruit, Wakkerstroom District, Transvaal; (3) Mr. J. Wentworth-Sykes, Grasslands, Natal Spruit, Heidelberg District, Transvaal. Their replies follow each query:—

1. Do you find that horses thrive on Teff hay?—Ans. (1) Yes. (2) All animals, including horses, thrive on it. Horses thrive on Teff-hay as an auxiliary ration; (3) Have fed horses on Teff-hay and ground mealies for years.

2. Does it keep them in good working condition?—Ans. (1) Yes, first-class; (2) It keeps them in first-class condition; (3) Tip-top.

3. Is it good for growing animals?—Ans. (1) Yes, especially for young sheep, ewes and lambs; (2) Young animals will require nothing else where a sufficient quantity can be given to them; (3) All farm animals eat it greedily, and for young stock it is to be highly recommended.

4. Do you find it an economical hay?—Ans. (1) Yes, very cheap to grow and goes a long way; (2) Good Teff-hay is economical, but badly cured or overgrown (rank) is wasteful, as the animals are likely to leave a considerable stubble; (3) It is as economical as any other grass hay, and more so than oaten hay, as there is less waste. (23.)

Mr. W. M. Struben adds:—“ I maintain that Teff is one of the finest foods for all stock that we have in the country to-day. Teff is going to revolutionise sheep farming in the Eastern Transvaal, and is going to do more towards the eradication of scab than any other factor I know of, as it is eventually going to make it possible to keep large flocks of sheep on the high-veld during the winter months, and render trekking unnecessary.

“ I have grown Teff for seven years. It is one of the easiest and cheapest of fodder crops to grow. As you are aware, we live and farm at an altitude of between 5,400 and 6,500 feet. We run about 4,000 sheep and from 500 to 600 head of cattle, on 7,500 acres, and never trek. Our wool has now a name, not only in South

Africa, but is inquired for from oversea. We also get top price for our slaughter stock. Teff is going to be our salvation, for we maintain that Teff-hay (not Teff-straw), together with maize silage, will keep any and all stock in tip-top condition, without any other food but what they can get off the veld.

"As you know, we can grow exceptionally fine oat-hay in these parts. Well, wish us Teff has entirely superseded oat-hay. Our stabled horses will compare favourably with any carriage horses of the towns, for condition, and do real hard work, and they get nothing but Teff-hay and a few crushed mealies, morning and evening.

"We are putting in 75 to 100 acres under Teff this year, to feed our own stock."

Mr. Gillespie writes: "My stable feed for years has been rarely anything but Teff, and I believe the condition of my horses leaves nothing to be desired. All whom I have come in contact with, and who have been users of Teff-hay, agree that it is first-rate. I have this morning received from a buyer of Teff seed the following information as to the value of Teff-hay as a stock feed: 'This fodder grass pleases me more than ever. It is so easy to feed, and no waste. My cattle, over 300 head, are looking splendid just now, after the winter, and I attribute this mainly to Teff-hay, of which I had 80 to 90 tons. Horses will keep in splendid condition all winter, on nothing but Teff.'"

Mr. H. J. Lourens, Uitval, Klerksdorp, writes:—"This crop can be reaped twice if sown in the beginning of January. If intended for cattle fodder, it must be cut just when seeding. It does well, too, as horse-forage, as I kept two horses, during the winter, simply on Teff grass."

"This crop should take the place of the usual manna crop in this district, as it gives a much larger yield and the stock prefer it to manna."—(H. H. Diron, Klipfontein, Middelburg, Transvaal.)

"Yesterday I had a visit from a gentleman who was driving one of the most spirited mares I have seen for some years. He assured me she had lived on *nothin'* but Teff grass for the last fourteen months; he had not given her forage, lucerne, oats or mealies. The mare was in 'show' condition."—(J. Wentworth Sykes.)

The writer's own horses are used six days in the week, and usually go to Vereeniging Station, nine miles away, three times a week, with ten mile journeys on alternate days. They have no other feed than Teff hay during the winter, yet they keep fat and in splendid working condition.

Mr. Burnett Wilson, of Bedworth, Viljoen's Drift, O.F.S., informs me that his horses refuse good oat-forage in favour of Teff!

In a second letter (24) Mr. W. M. Struben states that "Teff is our salvation. We do not grow to sell, either hay or seed, but purely for our own requirements. We have given up oats and millets entirely, as hay crops, as we find we can grow a Teff crop more cheaply and get a heavier yield per acre. We also find it is a better feed for all stock, when properly handled and cured."

ACRE YIELD OF HAY.

In India the first recorded crop gave only 1 to $1\frac{1}{2}$ tons per acre. (8.)

In a favourable season, in the Transvaal, two and a half tons per acre is considered a fair crop for the first cutting; but two tons is probably nearer the average. A second cutting may bring the total yield up to four or even five tons per acre. A crop of four tons per acre from a single cutting was reported in the season 1906-07. At the Government Estate, Tzaneen, 5,885 lbs. (2.9 tons) of dry hay was reported as having been obtained from an acre of ground in a single cutting.

Mr. Wentworth-Sykes (19) records a crop of nearly 3½ tons to the acre. Mr. W. M. Struben (24) obtained 152 tons from 63 acres, or a total yield of about 2½ tons per acre, in the season 1915-16; this is not a bad return considering the extremely unfavourable nature of the season. 'On 18 of the 63 acres the crop was indifferent, owing to weeds, drought, etc.; from 43 acres we got over two and a half tons per acre.'

COST OF PRODUCTION.

The cost of production is variously estimated by producers at 8s. to 12s. per ton in stack, or 20s. per ton baled. One farmer works out the costs as follows: Ploughing, 7s. 6d. per acre; harrowing and rolling, 4s.; seed and seeding, 4s.; reaping and curing, 4s.; wire, baling and wagon work, 20s.; total, 39s. 6d. per acre, carrying say 2 tons.

Mr. W. M. Struben (24) gives the total cost of production of 152 tons of stacked hay from 63 acres, "from time of ploughing to completion of stacks," at £57 16s., or 7s. 7d. per ton. "That includes cost of ploughing, sowing, seed, mowing, windrowing, cocking, carting, stacking and thatching the stacks, as well as £3 7s. 6d. for wear and tear on machinery, oil, etc. There is no charge for baling, as we did not bale. This crop was grown under very unfavourable conditions. We had excessive rains before ploughing; and after sowing we had a very hot, dry spell; in fact the last 5 acres we put in with Teff got burnt up."

MARKET VALUE.

The normal price of Teff hay in the Johannesburg market is about 3s. 6d. per 100 lbs. In 1910, six years after the first crop was reaped in the Transvaal, we find "Teff grass" (or, as the *Rand Daily Mail* spelled it for several months, "teft grass") first quoted in the daily press reports of the Johannesburg morning market.

The first published quotation I have been able to find was in the *Rand Daily Mail* for May 5th, 1910, though Teff had been sold on the market for some considerable time previous. The only comment which ushered the new hay into the produce list was the remark: "Hay was still cheap, and teft grass fetched 4s. per 100 lbs."

The following prices were realized from time to time:—

				Per 100 lbs.			
				s.	d.	s.	d.
1910—May	...	...	...	3	9	to	4 1
" July	...	...	...	3	3	to	4 0
" August	...	...	...	4	9	to	—
" September	...	...	...	4	0	to	5 0
" October 4th	...	...	...	5	3	to	—

			Per 100 lbs.		
			s. d.	s. d.	
1911—January 25th (1)	...	...	3 0	to	3 3
„ February	...	...	2 0	to	3 0
„ March	...	...	2 0	to	3 3
1912 (2)	...	...	6 6	to	7 6
1914—July	...	...	3 6	to	4 3
1915—March	...	...	2 0	to	3 6
„ September	...	...	3 9	to	4 6
1916—August	...	...	4 0	to	5 6

(1) "Teff was offered for the first time this year."

(2) Was realized at one time this year.

USE OF TEFF-SEED FOR HUMAN FOOD.

The traveller, James Bruce, F.R.S., who visited Abyssinia in 1768-73, in search of the source of the Nile, and whose "Travels" were published in 1790, gives a long and interesting account of the use of Teff for making bread, by the Abyssinians. His appears to be the first published account of this cereal, and as the book is not readily accessible, Bruce's observations on the subject are here quoted in full, from the copy in the library of the Rand Club, Johannesburg:—

"This grain is commonly sown all over Abyssinia, where it seems to thrive equally on every sort of ground; from it is made the bread which is commonly used throughout Abyssinia. The Abyssinians, indeed, have plenty of wheat, and some of it of an excellent quality. They likewise make as fine wheat-bread as any in the world, both for colour and for taste; but the use of wheat-bread is chiefly confined to people of the first rank. On the other hand, Teff is used by all sorts of people, from the King downwards, and there are kinds of it which are esteemed fully as much as wheat. The best of these is as white as flour, exceedingly light, and easily digested. There are others of a browner colour, and some nearly black; this last is the food of soldiers and servants. The cause of this variation of colour is manifold: the Teff that grows on light ground, having a moderate degree of moisture, but never dry, the lighter the earth is in which it grows, the better and whiter the Teff will be; the husk, too, is thinner. That Teff, too, that ripens before the heavy rains, is usually whiter and finer; and a great deal depends upon sifting the husk from it, after it is reduced to flour, by bruising or breaking it in a stone mill. This is repeated several times with great care, in the finest kind of bread, which is found in the houses of all people of rank or substance. The manner of making it is by taking a broad earthen jar, and having made a lump of it with water, they put it into an earthen jar at some distance from the fire, where it remains till it begins to ferment, or turn sour; they then bake it into cakes of a circular form, and about two feet in diameter: It is of a spungy, soft quality, and not a disagreeable, sourish taste. Two of these cakes a-day, and a coarse cotton cloth once a-year, are the wages of a common servant.

"At their banquets of raw meat, the flesh being cut in small bits, is wrapt up in pieces of this bread, with a proportion of fossile salt and cayenne pepper. Before the company sits down to eat, a number of these cakes of different qualities are placed one upon the other, in the same manner as our plates, and the principal people, sitting first down, eat the white Teff; the second, or coarser



A FIELD OF TEFF.

Botanical Experiment Station (Hoornkloof, Pretoria, South Africa) 1912-13

sort, serves the second-rate people that succeed them, and the third is for the servants. Every man, when he is done, dries or wipes his fingers upon the bread which he is to leave for his successor, for they have no towels, and this is one of the most beastly customs of the whole.

"The Teff bread, when well toasted, is put into a large jar, after being broken into small pieces, and warm water poured upon it. It is then set by the fire, and frequently stirred for several days, the mouth of the jar being close covered. After being allowed to settle three or four days, it acquires a sourish taste, and is what they call bouza, or the common beer of the country. The bouza in Atbara is made in the same manner, only, instead of Teff, cakes of barley-meal are employed; both are very bad liquors, but the worst is that made of barley."

The Botanist, Richard, in his book on the Flora of Abyssinia, published in 1851, gives us the second account (2) we have on record, as to the use of Teff for human food. He observes that "Teff is one of the cereals indigenous to Abyssinia. . . . The flour of Teff is very white, and produces a bread of excellent quality."

According to Mons. E. Coulbeaux (4), the white-seeded form of Teff-hagaiz (the long-season variety), is used for the table by the Abyssinian Court and Chiefs, while the seed of Teff-tseddia, the quick-growing variety, is of very inferior quality, and the flabby cake, or "tabita," made from its flour "is as disagreeable to chew as if it were mixed with sand." The flour of Teff "is only advantageously used," continues Mons. Coulbeaux, "in making 'tabita,' a kind of large fermented pancake. The 'tabita' of Thaf is most easily digestible, and has none of the bitterness of some other kinds of grain."

Whether Teff grain was known to the Greeks and Romans, is not clear. As Bruce quaintly puts it, "the various grains made use of in antiquity, are so lamely and poorly described, that, unless it is a few of the most common, we cannot even guess at the rest. Pliny mentions several of them, but takes no notice of any of their qualities, but medicinal ones; some he specifies as growing in Gaul, others in the Campania of Rome, but takes no notice of those of Ethiopia or Egypt. Among these there is one which he calls Tiphe, but says not whence it came; the name would induce us to believe that this was Teff, but we can only venture this as a conjecture not supported. But it is very improbable, connected as Egypt and Ethiopia were from the first ages, both by trade and religion, that a grain of such consequence to one nation should be utterly unknown to the other."

USE OF SEED FOR STOCK-FOOD.

Mr. W. Gillespie writes:—"Where I have second-grade Teff-seed on hand, I use it, in addition to the hay, for my horses, *in lieu of a grain ration*. I seldom use mealies. . . . I have experienced no difficulty in inducing my horses to take Teff seed as a grain feed. A small feed is placed in each stall, and the eagerness of the horse is shown by the manner in which he begins to eat. If the seed is free of sand and other dirt, and not fusty, I should indeed be surprised to find any left in the manger. The seed I use for feeding is never first-grade; I only use light grains and such as the grader rejects." (23.)

The use of the seed for human food, the heavy yield obtainable, and the low cost at which it can be produced, have suggested its possible suitability as a concentrated stock-food. In order to determine this point, the *Agricultural Supply Association* has forwarded a consignment of Teff seed to the *Imperial Institute* and has arranged that a careful test be made by large firms engaged in the manufacture of concentrated stock-foods. If Teff seed could be produced profitably at $\frac{1}{2}$ d. per lb. (8s. 4d. per bag) it is possible that it could be used in this way; but at a higher price than maize, it is doubtful whether it would be purchased.

ANALYSIS OF TEFF GRAIN.

The grain ("seed") of red Teff was analysed by Professor A. H. Church, M.A., F.C.S., who reported (3) as follows:—

Water	...	...	...	15.2
Albuminoids	...	...	...	8.2
Starch, etc.	...	...	...	68.1
Oil	...	...	...	2.8
Cellulose, etc.	...	...	...	2.8
Ash	...	...	...	2.9
				100.0

The ratio between the albuminoids, or flesh formers, and the heat givers, or force producers (calculated as starch), says Professor Church, is here 1:9. This ratio, he considers less satisfactory from the point of view of a human foodstuff, than that of the majority of the millets, but is near to that of the broom-corn millet (*Panicum miliare*).

YIELD OF SEED.

Bruce (1) observes that "the fruit, or seed, is oblong, and is not so large as the head of the smallest pin, yet it is very prolific, and produces these seeds in such quantity as to yield a very abundant crop in the quantity of meal."

The first crop grown by me in South Africa yielded seed at the rate of 1,500 lbs. per acre. (11.) Mr. J. Grierson obtained an average of 1,640 lbs. per acre from 7 acres, in 1912.

WEIGHT OF SEED.

Teff seed, being small and hard, packs well and weighs heavily. A commercial bag of seed weighs 225 lbs. net. Chondrometer weights, taken at the Johannesburg and other Agricultural Shows, over a series of years, show a range of variation between 60 and 72 lbs. per bushel.

We do not know that the best seed necessarily weighs the heaviest, but it is probable that this is the case, other things, such as purity, being equal.

In judging Teff-seed, weight per standard bushel is usually taken into account, and a good show sample will weigh up to 72 lbs.

QUALIFICATIONS OF GOOD SEED.

Freedom from weed-seeds—especially *Mest-brede* (*Amaranthus paniculatus* and *A. Thunbergii*) is an important consideration, for

though Teff is an excellent cleaning crop, it is not desirable to add more weed seeds to be buried and lie dormant in the soil—perhaps for several years. Mest-brede seeds are small, black, shining, rounded bodies, not easily removed from the Teff seed; but a very fine sieve will do it.

Other impurities, such as Teff chaff, soil particles, etc., should not be present in a well-cleaned sample.

Colour was at one time given great consideration in judging Teff seed, but we find that the darkest seed is not always the heaviest. But with red Teff (the only variety so far introduced into commerce in South Africa), the presence of white seeds is considered undesirable, as indicating immaturity.

COST OF SEED.

During the three years, 1904 to 1907, while the demand exceeded the supply, Teff seed sold at prices ranging from 5s. per lb., down to 9d. With increased production prices fell to 7d., 6d., 5d., 4d., 2½d., and finally 2d. per lb., at which price tons of seed can be bought to-day. In the year 1912, one farmer, alone, produced 30 tons, which he sold at 4d. per lb. in 100 lb. lots, or 5d. per lb. retail. Many farmers have done quite well from the sale of Teff seed.

TEFF SILAGE.

It is usually considered that the finer grasses, such as the English meadow grasses, and Teff, do not make good silage. It is also recognised by successful stock-feeders, that good hay is superior to silage, however good the latter may be, so that it is considered wasteful to ensile grass as long as it can easily and quickly be made into hay.

But in regions of torrential summer rainfall, it is sometimes difficult to make good hay, and the possibility of ensiling a crop leaves the farmer a loophole in a wet season. The present writer has never tried to make Teff silage, but is informed by Mr. Nicholson, of Arnold's Hill, Natal, that he has been very successful in making it, and that his stock eat it greedily.

FOR GREEN-MANURING.

The deficiency of humus in many of our South African soils makes it imperative that we should evolve an inexpensive and efficient system of green-manuring. For this purpose a leguminous crop is, of course, preferred, because it adds nitrogen as well as decomposing vegetable matter. But we have not yet met with the ideal legume for this purpose, and in the meantime Teff has been found a useful and economical substitute.

Among the first Transvaal farmers to try Teff for this purpose, were Messrs. Reynolds Bros., of Zandbaken, Val.

Two methods of treatment have been tried with success, viz.: (1) To sow after the main maize crop has been planted, and to plough-under during summer; (2) to sow in spring, either before or after the maize crop is planted, cut a crop of hay, allow the aftermath to grow, and plough-under before the ground dries out in autumn. Other methods may suggest themselves as the principle of green-manuring is more widely adopted.

FOR PASTURAGE.

Although an annual grass, and therefore one that must be resown from year to year, Teff has been successfully used for pasture. The first case to come under my notice in South Africa, was on a farm near Witbank, where Mr. L. Knapman grew Teff for pasture for dairy cows; this was illustrated in the *Union Agricultural Journal*, Vol. V., Plate IX., 1913. The idea was ridiculed by some farmers at the time, but there was more in it than was then generally known.

During the winter just passed (1916) the present writer has found Teff stubble, and Teff aftermath most valuable for keeping stock in condition, even though killed by frost and thoroughly dried out; animals would leave the maize stalks to feed on the frosted Teff as long as anything remained for them. The stubble has disadvantages as compared with uncut growth, on account of its prickly nature, but even that does not prevent their seeking it out.

This suggests a method of providing additional winter feed at little expense, and in a system of rotation that will help to clean the lands by summer-fallowing, without losing the advantage of a season's crop. After the main maize crop and the silage crops are planted, the ploughs can be set to work on fields which are to be summer-fallowed; this will turn under a lot of young weeds, which will soon rot with the summer rains, and help to add humus to the soil. As soon as a fresh crop of weeds is appearing on the newly-turned soil, the disk-harrow should be applied; this will destroy a large percentage of the weed infestation. Instead of harrowing down at once, with the tooth-harrow, a further crop of weeds might be allowed just to start; these could be harrowed off, and Teff might be sown behind or before the harrow, according to the nature of the soil.

These several operations might last until the middle of February. The resulting crop would, probably, in most localities where the system could be adopted, be caught by the first frost, but experience shows that it would still furnish admirable grazing and would greatly assist in carrying the stock through the winter.

Teff sown early in February might be allowed to seed and "cure-on-the-root." It would probably ripen some seed; this self-sown seed would be ample to produce a very fair crop of hay the following season. Volunteer crops are not, as a rule, to be encouraged, but the volunteer Teff-crop is usually worth cutting, even though not to be depended upon for the main crop.

TO CLEAN DIRTY LANDS.

Teff is one of the best crops for cleaning dirty lands, provided that care is taken to give the Teff-seedlings an equal chance with the weed seedlings. The only weeds it seems unable to overcome are Bermuda Quick-grass (*Cynodon Dactylon*) and Red-weed or Is-ona (*Striga lutea*).

If Teff-seed is sown immediately behind the tooth-harrow or anti-clog weeder, or if these implements are used to "harrow-in" the broadcast Teff, the germinating weed-seedlings are killed—or at least checked—and the Teff seedlings have an equal start; when this is the case there is little or no fear but that the Teff will smother the weeds, provided it is sown *thickly*. Some weeds, such

as the Wild Gooseberry (*Physalis minima*) will come up among the Teff, and start to flower and seed in a last effort to propagate the species ; but if the first cutting of Teff hay is taken early, the weeds will be cut off with it, the second crop of hay will be practically free from weeds and the ground will be left clean for the following crop.

Some farmers say they are not troubled with weeds, but only with grass. The word "weeds" includes grass, for a weed is "any plant growing in a place where it is not wanted."

To smother weeds by means of Teff, therefore, we must (a) sow behind the harrow, or harrow-in the seed ; (b) sow thickly and evenly. By "thick" sowing we mean about ten pounds of seed per acre or 21 lbs. per morgen. Some farmers recommend only 5 lbs., but that is not quite enough to make a good job of it.

"Teff actually chokes black-jacks, pigweed, and other noxious growths, and those that struggle through as a result of patchy sowing, being of slower development are usually cut before the weed seeds ripen, and, as Teff is a heavier stouter after cutting, the second growth obliterates them completely." (19.)

PART II.—CULTIVATION AND HANDLING.

REGIONAL DISTRIBUTION.

Teff matures so rapidly that it can be grown successfully both as a main crop and as a catch crop, on the High Veld. It is also well suited to the Bush-veld districts, where the rains are light, and fall intermittently or commence late in the season. It is not so well suited to regions of heavy or continuous rainfall, and it is there more difficult to harvest the crop. Being sensitive to frost it is purely a summer crop, and is therefore best suited to regions of summer rainfall. Being accustomed to heat, it can be grown in the warmer parts of South Africa. It is essentially a dry-land crop, and is not grown under irrigation ; it is scarcely likely that it would pay to grow Teff on land suitable for Lucerne.

The chief centre of production, at present, is the High Veld of the Transvaal, the north-eastern part of the Orange Free State, and the uplands of Natal, especially around Mooi River.

The short season and low rainfall required to produce a crop of Teff, and the low cost of production, make it suited to a much more extended area than it at present occupies. I see no reason why it should not be grown extensively in the Eastern Province, the Karroo, Bechuanaland, and the Bush-veld of the Transvaal. In the maize belt of Natal, also, Teff should prove useful for feeding to cattle after the maize stalks and stover are finished. On the large cattle ranches of Rhodesia, Teff should be most useful to supplement the natural veld during winter droughts.

Teff is also worth trial in the Western Province, to be sown with the last rains of Spring.

The fact that Teff furnishes useful grazing after it has been frosted, also greatly extends the area of its possible cultivation.

SOILS.

Red, sandy loams of a porous nature give excellent crops. I have also grown Teff on grey, clayey soils, and on black "turf," but on the latter type of soil there is danger of the crop becoming

top-heavy and getting "laid" by wind and rain. Teff has also done well on the sandy soils characteristic of the coal-measures, as, for instance, at Witbank and Ermelo. It thrives on the grey, sandy loams of the Standerton District and the red sandy soils of the Pretoria District.

Mr. W. Gillespie, for many years a very successful grower of Teff, writes as follows (23): "Teff grows very well on heavy, black soils, such as are common on the High Veld, but it is risky. If sowing is followed by heavy rains, before braiding has begun, the chances are that the surface will cake and thus prevent the shoots getting through. The grass is also coarser on heavy soils, and not so keenly relished by stock. It is better, therefore, to sow on lighter soils, sandy for preference; old mealie lands do very well."

In Abyssinia, according to Coulbeaux: "Teff prefers light, sandy soils, and adapts itself to the most sandy; it then produces slender, wiry stems, and supports a large weight of ear." (3.)

MANURES AND ROTATIONS.

Teff should not be grown year after year on the same field, unless a good dressing of fertilizer is first applied. The kind of fertilizer to be used will depend on the particular ingredient—nitrogen, phosphoric acid, potash, lime, et cetera—which is lacking in that particular soil. Stable or kraal manure is always beneficial. I have found that agricultural lime, at the rate of 500 lbs. per acre, had a beneficial effect on the Teff crop, but a heavier dressing (1,000 to 1,500 lbs. per acre), would probably have been still better. Bone meal, basic slag, super-phosphate, guano, nitrate of soda, all would probably prove beneficial. A green-manure crop, such as cow peas, soy beans, velvet beans, etc., ploughed in, would also benefit a succeeding crop.

Teff is particularly well suited for a rotation, because it is such a good "cleaning crop." Teff, maize, cow-peas, and potatoes suggest a rotation which might be varied to suit local conditions and requirements. Some farmers claim that Teff benefits the succeeding maize crop, but as it is a somewhat exhaustive crop (24), this does not seem likely. Beneficial effects may, perhaps, follow, owing to the cleanliness of the land after a Teff crop.

PREPARATION OF THE GROUND.

Teff seed, being very small—between tobacco and lucerne seed in size—is easily buried; buried seed cannot germinate. Therefore the seed-bed should be level and the tilth very fine—nearly as fine as a tobacco seed-bed, and, if anything, finer than well-prepared lucerne land—to give the best results. It should be free from old maize stalks and rubbish, such as stalks of Mexican marigold, mest-brede, etc., which spoil the appearance of the hay. Plough the ground well, disc-harrow, and work down well with the zig-zag harrow. When the tilth is fine enough the seed may be sown and worked in with a very light harrow, or anti-clog weeder; follow with a Cambridge roller. Some farmers never harrow after sowing (19), but rely on the Cambridge roller to bury the seed. "The use of the roller pays well for the trouble, as the crop stands much closer than if finished off with the harrow only."—(W. Gillespie, 23.) But the rolling should not be done while the surface soil is wet or it will pack too much; I have known cases where the crop had to be ploughed up and resown on this account.

METHOD OF SOWING.

When sowing Teff-seed on a small scale, some farmers mix the seed with dry sand or sandy loam, in the proportion of 1 to 20, or even 1 to 40, in order to ensure even sowing. The seed may be sown with a "fiddle," Cahoon broadcast sower, barrow drill, or a seed-drill having a grass-seed attachment. The seed must not be buried; it is usually sown broadcast behind the tooth-harrow; after sowing it is a good plan—on some soils—to follow with the Cambridge roller, which presses the seed into the ground and crushes the clods not broken by the harrow.

Mr. Wentworth Sykes writes:—"As a large grower, I use a Cahoon broadcast sower—a little machine which costs £1—carried on the breast and worked by turning a handle. Half an hour's experience will teach the farmer how far to open the little gate through which the seed falls into the revolving wheel which spreads it, and with this machine I can comfortably sow 20 acres in a working day." (19.)

It is important that a thorough harrowing be given at the time of sowing, to kill any weed seeds that may be germinating; if seeds of weeds such as mest-bredie (*Amarantus paniculatus* and *A. Thunbergii*) and stink-blaar *Datura Stramonium* and *D. Tatula*) get a start of the Teff seedlings, they keep ahead of it, but if the Teff gets the start of the weeds it usually smothers them by giving them no chance for light or air; a day or two between harrowing, and sowing the Teff, may be enough to give the weeds an undesirable start.

Mr. Wentworth Sykes never harrows the ground *after* sowing; "latterly I have found that the first rain does all the harrowing necessary." (19.)

Mr. Gillespie (24) finds " broad-casting by far the best way of sowing, much quicker and more satisfactory than by machinery. Mix 6 lbs. of seed per acre into as much sand as you would sow to an acre. In sowing I have a knotted line, carried by two natives, knots 4 yards apart; for each man who may be sowing a knot is given, and each man sows to his mark. Thus: | . . . | . . . | . The dots represent the sowers and the upright dashes the line bearers; an umfaan (a small boy), about the middle of the line is advisable. Use the same size of can for each sower, so that a check can be made on the regularity of sowing (I use 14 lb. grease cans), and let all throw simultaneously; the first finished whistles, and all stop for re-filling; 100 acres or more can be sown in a day by ten boys. Line-bearers hold the line only two yards beyond the outside sowers. The one line-bearer erects small beacons, or places pegs, to indicate line of ground covered, the other bearer takes this line on the next lap. The seed being fine, can only be sown evenly, down wind."

SEEDING PER ACRE.

The quantity of seed to be sown to an acre of ground depends on the purpose of the crop. If it is for hay only, the sowing should be lighter than if it is intended also as a "smother crop" for weeds.

It is possible to grow a hay-crop with only two pounds of seed per acre, but this is too little to give the best results. My own sowing is usually seven pounds of seed, based on the recom-



THE FIRST PUBLISHED ILLUSTRATION OF TEFF.

Photographed from the plate in Bruce's *Travels*, Vol. V. (1790), by kind courtesy of the Committee of the Rand Club.

mendation of Mr. Turner, who was at one time a very successful Teff-grower near Springs. Mr. Wentworth Sykes, writing in 1911, recommended four pounds; "I used to advocate three pounds, he says (19), but found four pounds gave a finer texture to the grass and in consequence it commands a higher market value."

As the Teff-plant stools out freely, it is probable that a thin sowing will in time give as heavy a crop as a thicker seeding, but it will take longer time to thicken up than if sown more thickly, and thus give light, air and space for weeds to spring up. Therefore if sown on foul lands, the seed should be sown thickly—ten pounds per acre has been found satisfactory for this purpose.

TIME OF SOWING.

Teff seedlings are as fine as those of the finest lawn-grass and are sensitive to excessive heat and drought until established. In choosing the time for sowing, therefore, it is well to avoid those months when long dry spells may be expected; of course, these periods vary according to the locality, and cannot be specified here. A period when a rainstorm is gathering is a good time to sow. In Pretoria it was found that the period from the middle to the end of October was the best for the first sowing, and the early part of January for the second. It is also a good plan to arrange the sowing so that the crop will not be ready for cutting during the normal period of heaviest rains; over much of the Transval this is from the middle of January to the end of February; as the summer growth of Teff takes about two months, it is usually undesirable (with us) to sow between the middle of November and the end of December. In seasons when the rains are erratic, one sows Teff when there is enough moisture to bring it up, taking chances on a dry spell, for after all, the seed is cheap and quickly sown, and growth is so rapid that there is ample time for resown crops to reach maturity.

Mr. W. M. Struben sows in January, and cuts in April, "when the weather is good" (23). . . . We sowed the 63 acres of Teff from January 11th to 17th inclusive; commenced to mow on April 13th (1916); and we finished our stacks by May 10th (24).

Mr. W. Gillespie sows usually in the latter end of November and during December. "This allows of reaping in March, early, and ahead of frost. Early sowing has the disadvantage of light rains at the start of the season, sometimes, which results in uneven germination, which is bad for seed growing. (23.) If sowing be done in end of November or early December the likelihood of getting suitable weather for the curing of the hay is fairly reliable. Should earlier sowing be preferred, or more convenient, the first cut might be put into an ensilage stack, while the second could be cut for hay."

Mr. J. Wentworth Sykes, Natal Spruit, sows from the beginning of October until the end of January (23).

At Vereeniging, the writer sows usually from October to the early part of February, according to season and general condition of the farm work.

RAPIDITY OF GROWTH.

One of the great advantages of Teff (the *Tseddia* variety)

over other hay crops is found in the rapidity of its growth, which enables a farmer to sow it as a catch crop at any time of the summer season from September to February, and to secure one, two or even three crops. "Teff, if it once gets a good rain to cause the seed to germinate, is of remarkably quick growth. I have cut my first crop for hay seven weeks from the day I sowed it. When it grows sufficiently to shade the sun's rays from its roots, its progress is simply phenomenal." (19.)

HARVESTING FOR HAY.

Teff makes a beautiful hay if carefully prepared ; Teff-hay more closely resembles English meadow hay than anything else grown in South Africa. But much of the so-called Teff-hay on the market is merely straw or over-ripe hay ; Teff grown for hay should be cut before it is fully ripe to obtain the best quality. The best hay is made by stacking and allowing a certain amount of fermentation ("heating") to take place in the stack. But the local market prefers the bright, green colour of hay baled directly from windrows or cocks in the field rather than the duller colour of real hay fermented in the stack. Those who are growing for the market should bear this in mind, but those who grow for their own farm use would be well advised to cure it properly in the stack before baling.

Being fine in leaf and stem, Teff dries quickly, and must not be left long exposed to the sun ; the length of time will depend on the weather. In bright, sunny, dry weather, Teff cut in the afternoon may be raked into windrows after the dew is off the next morning ; these windrows may be cocked the same afternoon, against a possible rain at night, and may even be stacked the next day, though another twenty-four hours in cock would probably be beneficial and save the labour of pulling down the stack in the event of over-heating.

Mr. Gillespie recommends to "cut with mowers and allow it to lie until next day, when the ordinary dump rake can be used in bringing it into windrows, after which a tilt rake, to bring it together, when cocks can be set up. Use wagons with hay tops for bringing on to stacks, as a dragbeam collects sand if used on cultivated land, and this spoils the hay."

Teff bales well, into compact, heavy bales, 75lb. to 100lb. weight. The usual bale seen on the Johannesburg market is 16 x 18 x 36 inches, which measures exactly 6 cubic feet. These are usually wired with three wires. It takes 150 to 170 of these bales to fill an S.A.R. short truck. Some farmers allow their Teff to ripen before cutting, then thrash out the seed for sale, bale the straw, and sell it as Teff-hay ; this has tended to injure the Teff hay industry, and may be the reason why the market prefers an uncured sample, so long as it has kept its colour. The best stage at which to cut Teff for hay is when the ears have headed out and are just turning grey, and when but a very little dark seed can be rubbed out by hand, the rest being still white or light coloured ; the grass gets harder, less palatable and less nutritious the longer it stands.

HARVESTING FOR SEED.

If seed is desired, the crop should be allowed to get ripe before cutting, or the seed will be immature and not give a good ger-

mination. But it should not be allowed to get too yellow, or most of the seed will shake out and be lost. By sowing early, some growers cut the first crop for hay and allow the second crop to run to seed.

VOLUNTEER CROPS.

In the Transvaal Teff "volunteers" freely from self-sown seed, and advantage is sometimes taken of this fact to produce a medium crop of hay at low cost. Some farmers sow in January, and when the crop is nearly ripe, turn their stock on, depending on the seed which is shaken out to resow the ground for another season.

SOME DIFFICULTIES IN HANDLING.

Teff is an easily grown crop, and is not subject to many diseases or pests. The main difficulties to be avoided in handling, are:—

- (1) The effects of a protracted drought when the seed is germinating or the seedlings are just above the ground;
- (2) The effect of heavy and continuous rain when the crop is nearing maturity.

When an early crop is desired, the first of these must be risked. Loss from layering may be greatly reduced by sowing not less than two months before the usual period of heaviest rainfall. Thus, in Pretoria, Teff sown in December was harvested with difficulty.

DISEASES AND PESTS.

The only diseases and pests to which Teff has so far been found subject in South Africa, are Is-oná (*Striga lutea*) and a leaf rust (*Uromyces teffii*, Pole Evans).

Is-oná, also called Witch-weed, Red-weed, Fire-weed, and Rooibloemetje, is a parasite which lives on the roots of the maize plant, Teff, Kaffir-corn, sorghum and several other grasses. In the dry season of 1915-16, it very seriously reduced the second crop of Teff, causing it to die out in large patches. It does not appear to affect the first crop (of early sown Teff) seriously, and in this we find a means of combating it. By sowing early (October and November) we can get a good cutting of hay, even on infected land. A second crop is allowed to come up; this will be badly infested with the parasite, and before the latter matures seed, the whole crop—Teff and Is-one together—is ploughed under, destroying the Is-oná and adding green-manure to the soil.

The Rust of Teff is a new species of *Uromyces*, recently described by Mr. Pole Evans. In wet, warm seasons it attacks the crops somewhat heavily, and must reduce the value of the hay to some extent. There is no known treatment of the seed that is an effective preventive; dressing it with chemicals has no known effect against rust. Rotation of other crops, after Teff, should be practised as far as possible.

CULTIVATION IN ABYSSINIA.

The following notes on the cultivation of Teff in Abyssinia by Mons. E. Coulbeaux, Missionnaire Apostolique en Abyssinie, were sent to the Foreign Office, by M. de Martino, then Italian Agent and Consul-General at Cairo, and published in the *Kew Bulletin* (3).

Thaf-hagaiz is so called from the name of the season hagaiz, "which, according to Abyssinian reckoning, includes all our winter

and the commencement of our spring ; it is sown at the end of Megabit, in Myazga and Ghembot (March, April and May)."

Thaf-tsedia is so called "from the name of the commencement of the rainy season, which follows that of hagaiz and precedes that of Kerem ; it is sown in June and at the commencement of July."

" Hagaiz and Tsedia cannot be sown indifferently for one another. The experiments which the natives tell me have been made, have not met with much success. The seed of Thaf-hagaiz must be used for the first sowing, and that of Tsedia for the second."

Coulbeaux concludes that the superior quality of the grain of Thaf-hagaiz is due to its more vigorous growth from its being two months longer in the ground. But he recognises that they represent two very distinct varieties.

" These seeds," he adds, " almost equal barley in their growth, and the rapidity with which they come up. Sown at the end of March or in April and May, they arrive at maturity at the beginning of September. Sown in June or July the crop may be reaped in October.

" The land requires to be prepared and cleaned by three or four ploughings before sowing ; but it is true that the ploughings in Abyssinia are light and not very deep. It is sown thickly on the surface of prepared ground. It is afterwards lightly hoed, if necessary, when it has come up.

" It is not necessary to wait until it is quite dry, like barley, to cut it, for when too ripe and dried, the grain sheds in the wind and at the least shock. It is cut as soon as the green ear turns to grey, in the early morning, and is placed in heaps with the ears inwards, and covered to preserve it from the rain ; it is then left to ripen and undergo a certain amount of fermentation."

According to Richard (2) Teff in Abyssinia requires four months from the time of sowing till the grain becomes perfectly ripe. In the neighbourhood of Gondar, Teff is sown in August and repeated at the end of November or beginning of December. In good years it returns about 40 times the seed, and only 20 times in bad years.

PART III.—HISTORY AND GEOGRAPHICAL DISTRIBUTION. NAMES AND VARIETIES.

Teff is the name used for this grass by Bruce (1), in his *Travels*, published in 1790, and, being the earliest published name known to us, should by right of priority be retained.

The names used in modern Abyssinia, according to Coulbeaux (4), are *Thaf* (in the Tigrina language), or *Thief* (in the Olmharigna language).

Other names, or spellings of the same name, are given by Richard (2), as " *Ttheff*," " *Thaff*," and " *Tteff*."

Coulbeaux (4) distinguishes two varieties : " White Thaf " and " Red Thaf. " " Both are, moreover, of two different qualities, according to the time of sowing, and are in consequence distinguished by the names of the seasons ; ' *thaf-hagaiz*' and ' *thaf-tsedia*' . . . Thaf-hagaiz is of slow, and Thaf-tsedia of rapid growth. The difference between them, both in the case of the white or red, is quite perceptible to the naked eye, by the want of plumpness characteristic of the Thaf-tsedia, relatively to the other."

Richard (2) observes that 'like all other cereals, Teff presents several varieties, some depending on its relative height, others on its general colour. Thus there is:—

- " 1. Green Teff: or Tchangar.
- " 2. White Teff: or Ttsada Ttheff.
- " 3. Red Teff: Beneigne Ttheff.
- " 4. Purple Teff: Kqhaie Ttheff.

" These different varieties are all cultivated alike."

ORIGIN.

Teff is a native of the Uplands of Abyssinia, where it is cultivated as a staple cereal crop by the natives. Yet, unlike other aboriginal cereal crops, such as Kaffir-corn, Rapoko, and Pearl-millet, Teff appears to have been entirely unknown, up to this day, to the African tribes outside of the narrow confines of the Abyssinian Empire. Kaffir-corn, on the other hand, is known and grown from one end of the Continent to the other and from the Atlantic to the Indian Oceans, while Maize, unknown to the Old World before the conquest of America, is nearly as well-known and widely distributed. Teff is most easily grown, and is very prolific; how comes it, then, that it was not carried by the Bantu races from one end of Africa to the other? This problem gives rise to much speculation. Lack of palatability can scarcely be considered an adequate reason, for Rapoko (*Eleusine Coracana*) is said to be far less palatable, yet it is grown by native tribes from the banks of the Nile, southwards to the warmer parts of the Pietersburg District of the Northern Transvaal.

In this connection it is significant to note that the Transvaal Native is already beginning to grow Teff hay for winter feed for his cattle. A plot of about half an acre was grown this season (1915-16) by a native on my farm, quite voluntarily—in fact I can only surmise that the seed was stolen from my own store room.

It is strange, considering the trade which existed in ancient times between India, Arabia and the east Coast of Africa, that Teff never accompanied or followed Kaffir-corn, Pearl Millet and Rapoko to India (assuming, as seems probable, that these crops were introduced from Africa to Asia), or if it ever was taken to Asia, that it was never adopted there as a farm crop.

WHERE GROWN IN ABYSSINIA.

Richard (2) states that Teff is cultivated in a great number of Provinces in Abyssinia, at altitudes varying between six thousand and seven thousand feet above sea-level. Bruce (1) observes that it is not produced in the low or hot country, the Kolla, that is, in the borders of it; for no grain can grow, as I have already said, in the Kolla or Mazaga itself; but in place of Teff, in these borders, there grows a black grain called Toccusso [*Eleusine Coracana* ?]. . . . Of this a very black bread is made, ate only by the poorest sort; but though it makes worse bread, I think it makes better bouza."

According to an anonymous writer in the *Kew Bulletin* (10), "Teff is . . . cultivated for the sake of its grain, all over Abyssinia."

Both Teff-hagaiz and Teff-tseddia are cultivated, according to Coulbeaux (4), in the warm regions of the "Konalla," or lowlands at an altitude of from 1,300 to 1,800 metres, and especially in the temperate regions of the "Ouayne-Dega," at an altitude of about 1,800 to 2,400 metres.



The first crop of Teff grown in the Transvaal. (Botanical Experiment Station, Pretoria, 1904.)

INTRODUCTION INTO THE CIVILIZED WORLD.

The introduction of Teff to the civilized world was brought about in 1886-87, through the efforts of the Director of the Royal Botanic Gardens, Kew, aided by the Foreign Office, London, and the officer commanding the Italian garrison at Massowah.

In 1886 inquiries were made at Kew for seed of Teff, and it occurred to Mr. Thiselton-Dyer, the then Director of Kew, "that the grain might be very advantageously introduced to certain hill stations in India, to elevated portions of our Colonial Empire, and, indeed, to all places where maize and wheat cannot be successfully cultivated." (3.) He therefore took up the matter at once and sought the aid of the Consular Service of the Foreign Office. In a letter, historic in the annals of Teff, dated 23rd June, 1886, Mr. D. Morris, the Assistant Director, briefly outlined the value of Teff to the Abyssinians, and concluded: "Mr. Thiselton-Dyer would, under these circumstances, esteem it a favour if you will be good enough to lay this letter before Lord Rosebery, and ask that the Vice-Consul at Berbera be instructed to endeavour to procure a bushel or so of seed of Teff and forward it here by first convenient opportunity."

The Foreign Office took up the matter with Her Majesty's Chargé d'Affairés at Cairo, Mr. G. H. Portal, who succeeded in securing one bag each of White and of Red Teff, through the courteous assistance of Mons. G. Verranzi, the Italian Acting Consul-General, and of General Géné, Officer Commanding the Italian garrison at Massowah. The letter forwarding the seed was dated Cairo, 16th October, 1886.

General Géné, in forwarding the consignment, explained that both the White and Red Teff are cultivated in the same manner, but that the former is more generally preferred by the well-to-do natives on account of its colour.

He also enclosed a useful memorandum (4) on the cultivation of Teff in Abyssinia, from Mons. E. Coulbeaux, Missionnaire apostolique en Abyssinie, dated Olkraur, 27th September, 1886.

DISTRIBUTION FROM KEW.

We have no information as to the exact dates on which the Teff seed was received at Kew, and distributed to the Colonies, but in the *Kew Bulletin* for 1894 (10), it is stated that "seed of Teff was received at Kew in 1886 and distributed to numerous establishments in India and the Colonies"; the article also quotes from reports received from British Guiana, India and Australia, dated 1888. It is obvious, therefore, that the seed was distributed in the latter part of 1886 or in 1887.

"The grain is reported to make 'an excellent fine hay' in British Guiana, and to mature in six or eight weeks from time of sowing. 'For this purpose Teff is well worth cultivating. It is cleaner and brighter looking than any other grass, and is readily eaten by cattle and horses.' The reports from Australia and India are equally favourable. The value of this plant for fodder purposes is exceptionally high. Its chief merits in this respect are the short time it takes to mature, and its suitability to thrive in dry, sandy regions, where few other grasses would flourish equally well." (10.)

FIRST INTRODUCTION INTO SOUTH AFRICA.

In addition to the places already referred to as having received seed from Kew in the 1886-7 distribution, seed was sent

to the Natal Botanic Gardens, Durban. In his Annual Report for 1887 (5), the Director, Mr. J. Medley Wood, A.L.S., reported as follows:—

“ I received from the Director of the Kew Gardens a small bag of seeds of this plant, which is used in Abyssinia for making bread. The seed is very small, and it appeared to me that it would scarcely find favour in Natal as a cereal, though possibly in some parts of the Colony it might be found useful as a fodder plant. I therefore, after having the seed tested, and finding it quite good, distributed it in small packets to persons willing to give it a trial, and hope in a future Report to be able to record the results.”

Writing in June, 1911, Mr. Medley Wood reported (20) that this seed was distributed among twenty farmers, seventeen in Natal, two in Zululand, and one in the Transvaal. The names of the recipients, and the districts in which they lived, were not reported, but the Transvaal locality was probably Barberton or neighbourhood, where a botanical correspondent of Mr. Medley Wood resided for some time.

In 1888 Mr. Medley Wood wrote (6): ‘ This will, as I suspected, have no value as a cereal in Natal, but very favourable reports have been received of it as a quick-growing fodder-grass.”

Again, in 1889, he reported (9): “ It was highly thought of as a quickly-growing grass, though as a cereal it proves, as I had suspected, to have no value in Natal. Whether or no the recipients of the seed have thought it of sufficient value to continue its cultivation, I have no information. De Schonburgk says that it stands drought well, and is a good grazing grass.”

As far as we can trace, this first introduction of Teff into South Africa, ended here. None of those who tried it appear to have had sufficient interest in the new plant to continue to grow it, and it appears to have suffered a premature birth as far as South African agriculture is concerned, for it was not in cultivation when I came here in 1903.

CAUSES OF FAILURE OF EARLY INTRODUCTION.

The object of the proposed introduction was to provide an additional cereal crop for drought-stricken regions in India and the Colonies; it was thought that Teff, being a relatively drought-resistant crop of rapid maturity, might thrive in regions where the rainfall was irregular in its incidence. In this respect, however, the experiment was a failure, for in the thirty years since its distribution it has nowhere outside of its native country—as far as we can learn—been adopted as a cereal food-stuff.

The failure may have been due in part to the fact that yields from the trial plots were so small as to appear unprofitable; and in part, perhaps, to the fact that the variety introduced was that known as *Tseddia*, the grain of which is described as of “ very inferior quality ” as a bread-stuff, the flabby cake or “ tabita ” made from its flour being “ as disagreeable to chew as if it were mixed with sand.” (4.)

When first introduced, nothing appears to have been known of the value of Teff as a hay, or fodder grass. Neither Bruce nor Richard had mentioned this use of the crop; probably it was unknown to them. It was only when Teff had been tested in India, and the Colonies to which seed had been distributed, that its feeding value as a hay-grass was demonstrated.

But when this was once made known in British Guiana, India, Australia and Natal, it is remarkable that the grass should have been allowed to die out. It is clear that it was highly thought of in these countries, then why did it not establish itself there as it did in the Transvaal and Natal after its second introduction? There are two probable reasons: (1) The smaller and more conservative agricultural population may have been less alive to the advantages of a new hay-grass; (2) failure to follow up the new introduction. In the work of seed and plant introduction and acclimatization, success very rarely follows the first attempt; but perseverance, repetition of the experiment, study of controlling conditions, and removal of inhibiting factors, often result in subsequent success.

A well-organized system of co-operative field experiments on private farms, is a very necessary adjunct to any Government Department of Agriculture. To overcome the indifference or conservatism of the rural population, it is not sufficient to maintain demonstration plots on Government farms or experiment stations, nor to issue publications broad-cast, nor even to tour the country lecturing, valuable as all these agencies are.

Generally speaking, new crops are first taken up by theorists or by men trying to "get rich quick," to whom seed-catalogue advertisements of novelties appeal; such men are often but in-co-operative experiments with farmers, by which *selected farmers who knew how to grow crops*, were taken into the confidence of the Department, and induced to try new and promising plants, under supervision, Teff would not, even to-day, have been a success, any more than it has been in Australia, India or the United States.

INTRODUCTION INTO CALIFORNIA.

My attention was first attracted to Teff when preparing an Index to the earlier volumes of the *Kew Bulletin*, while attached to the Kew Staff in 1891-2. When the article on Tropical Fodder Grasses (10) appeared in 1894, I was studying the grass flora of California and it occurred to me that Teff might prove useful in warm, dry parts of that State. I therefore applied to the Director of Kew, who courteously supplied a little seed for trial.

This was tested in the Botanic Garden of the University of California, and subsequently at the State Agricultural Experiment Station, in both cases with very satisfactory results; the yield and quality of the grass and the ease with which it cured into hay, attracted very favourable attention.

But California is a region of winter rains, and the winters are too cold—in the principal stock-raising districts—for Teff to thrive in winter. Lucerne is the staple summer forage crop, being grown under irrigation, and no farmer who could grow Lucerne cared anything about an annual hay-crop like Teff, where water and the cost of irrigation were expensive.

There are localities in California where Teff may yet prove a great boon. But at that time the Experiment Station authorities could not see any value in it, would not offer it for distribution among the farmers of the State, and even omitted any reference to it in their Reports on the Station Experiments. However, in November, 1898, I was able to include Teff in the Exchange Seed-list, published by the Agricultural Experiment Station; this was

a bare list of seeds, without any descriptive account, and I had no means of calling the attention of the farmers to the potential value of this grass. At that time the Experiment Station lacked a well-organized system of co-operative experiments ; though seeds were distributed for experimental purposes, for a modest sum to defray expenses, and reports on them were received and published, there was no means of regular personal inspection and report by a competent experimentalist attached to the Station Staff, able to explain the causes of failures and to suggest alterations in methods of treatment which might lead to success.

SECOND INTRODUCTION INTO SOUTH AFRICA.

When I accepted the position of Government Agrostologist and Botanist in the Transvaal Department of Agriculture, in 1903, I brought with me seeds of the most successful grasses which I had grown at the State Agricultural Experiment Station at Berkley, California, including Teff and New Zealand tall fescue (*Festuca arundinacea*). In the Manuscript of a Report on crops suitable for the Transvaal, prepared by me in 1903 but unpublished, I find Teff included with the following comment :—“ 9.—Teff (*Eragrostis abyssinica* Link). A slender, leafy annual grass, 2 to 4 feet high. . . . It matures early and may be of some value for hay in the Transvaal. It seeds profusely and seed should be easily and cheaply harvested.”

From the first, Teff proved a success ; in my first Annual Report to the Director of Agriculture, dated 28th October, 1904, I wrote (11) :—

“ Teff (*Eragrostis abyssinica*) is an annual grass of Abyssinia, leafy and fine in quality, and 2 to 4 feet high, seeding heavily ; it makes very rapid growth, maturing in seven or eight weeks from time of sowing, and if cut before the seed develops, a second crop can be obtained from the same stand ; it makes an excellent catch-crop for hay, two successive cuttings being obtainable during the summer on unirrigated land. The plants seed heavily, our yield of seed from a small plot having been at the rate of about three-quarters of a ton (1,500 lbs.) per acre ; the seedlings are not readily scorched by the intense heat of summer, which is a most important point in this climate ; its adaptability to our conditions is shown by the way in which ‘ volunteer ’ seedlings came up all over our ‘ experiment grounds ’ under the most adverse conditions. Stock eat this grass readily, both green and when made into hay. Teff is a most promising plant for further experiment. . . . Seed is now offered by French dealers at about 3s. 2d. per lb. ; it weighs about 63 lb. per bushel.”

Seed harvested from this crop was distributed among selected farmers in different districts of the Transvaal for trial under ordinary farm conditions and to test its adaptability to different parts of the country. My system was to issue the seed free of all cost to the farmer, who signed a written undertaking to return to me from his crop twice the amount of seed supplied. In the case of failure of his crop this condition was not enforced. The majority of bona fide farmers loyally carried out their agreement, and where they desired to retain all the seed for further experiment, they often offered to pay cash for it.

In my Annual Report to the Director of Agriculture for the year 1904-05 (12), I wrote :—“ Mr. V. L. Robertson, of Amersfoort, reports : ‘ In this grass [Teff] I think we have struck the desired

hay for the High-veld; sown 6th November it was 3 feet high in February and ready for cutting for hay; if cut then, it would have matured for a second crop of hay in April. Its yield of hay per acre must be tremendous. On account of the soft, thin straw, it dries and cures very quickly. Of all my experiments this has pleased me more than any.'

"The general consensus of opinion is that Teff is a most valuable hay-grass. Under favourable conditions it will mature in two months from seed; the seed scatters easily and freely, readily producing a volunteer crop. The yield of seed is remarkably heavy [rendering it cheap and easily obtainable]. The fact that the farmers appreciate the crop is practically illustrated by the requests received for permission to retain, and pay cash for, Teff seed which is due to the Department as a return for the seed originally supplied."

In February, 1905, my then assistant, Mr. Hugh C. Sampson, B.Sc. (14), reported that Teff sown at the Botanical Experiment Station on 26th November, 1904, was cut for seed on 20th February, twelve weeks from sowing, and gave a yield of 10,285 lb. of green forage per acre, having had only 7.12 inches of rain during the growing period. Though it has only been cut two days, the roots are already starting new growth for a second cutting."

In my Report for 1905-06 (15), I noted that 'out of twenty-two co-operative trials all but two reported unqualified successes, and the failures were due to locusts and hail; farmers cannot speak too highly of this crop. One of them writes: 'This can no longer be looked upon as an experiment; its success is assured.' The consequent demand for seed is greater than the supply, owing to the fact that nowhere else than in Abyssinia has this become a commercial crop. But next season, however, I expect that all difficulty in this direction will have been overcome as so much ground is being sown down to Teff this year.'

Teff seed was advertised by the Division of Botany of the Transvaal Department of Agriculture, for distribution for the purpose of co-operative experiment, in the *Transvaal Agricultural Journal*, July, 1905 (14a).

In my Report for 1906-07 (16) my then assistant, Mr. H. Godfrey Mundy, reported that out of twenty-eight co-operative experiments, carried out in all parts of the Transvaal, twenty-one were entirely successful, in one case a yield of 4 tons of hay per acre being reported. It was also highly spoken of, in several cases, as a smother-crop for weeds. A progressive farmer in the Wakkerstroom District wrote: "It is a grand stand-by at the end of the winter, and I don't expect to be without it in future. All stock are fond of it and do well on it if cut before the straw gets strong. I am now selling seed." From the Ermelo District a farmer wrote: "I have grown Teff most successfully and have supplied farmers round about me with over 100 lb. of seed free."

DIFFICULTY IN SECURING A MARKET FOR THE HAY.

But although Teff took with the progressive Transvaal farmer from the start, the hay did not become a commercial article till some years later. As is usually the case with new farm crops, Teff-hay did not sell well when first offered. But it was first grown for farm consumption, and only the surplus crop was put on the Johannesburg market. I well remember how disappointed I was

at the reports of the earlier sales ; they realised no more than ordinary rough veld bedding, and were in fact bought for the same purpose ! But that was only because the townsman did not know anything about the new hay. Steps were taken to have trial lots tested by large consumers, but to move a market requires either the whole-time energies of a shrewd business man or some fortuitous accident. I had other things to do and could not act as Trades Commissioner for the introduction of Teff-hay on to the Johannesburg market ! But the accident happened. As far as I can learn the details, they were as follows :—

THE STORY OF ITS SUCCESS.

A farmer having more Teff-hay than he required for the consumption of his stock, decided to sell the surplus, and sent it to the Johannesburg market. As stated above, it did not sell well ; none of the buyers knew the grass, and it was finally sold for stable bedding. This was disappointing, and I, personally, was afraid it might check the spread of the new crop. But I need not have had any doubts. Evidently the low price was profitable to the grower, for it was only the surplus of his crop ; the balance was used to feed his own stock, and doubtless paid him well for the cost of production, so that what he sold would be clear profit.

A few farmers continued to send small lots of Teff-hay to Johannesburg, some of which were bought for bedding-down horses. As bedding, Teff is softer than the ordinary bedding cut from vlei sedges and *Arundinella Ecklonii*. One lot was bought for a racing stable, as being superior to ordinary bedding. Rumour has it that the owner of this stable found his racers eating their bedding in preference to the oat forage in their racks ! Being an observant man, and realising that the price he paid for the new bedding was much lower than for Lucerne hay or oat forage, he decided to buy more and feed it. To his surprise (the story goes) his horses not only ate all of the Teff-hay, but began to improve in condition. This was enough for him ; he bought all that was offered on the market, and inquired for more. Dealers and buyers soon got wind of this, and the price began to improve ; it was not long before it rose from 8d. or 9d. per bale (about 70 lb.), or 20s. to 22s. 6d. per ton of 2,000 lbs., till it commanded the same price as Lucerne hay, i.e., 5s. to 7s. 6d. per 100 lbs., or £5 to £7 10s. per ton.

A MARKET GAINED.

Once a market was established, production went up by leaps and bounds ; the markets were soon flooded, and the price fell to a more reasonable figure, i.e., £3 10s. to £5 10s. per ton. But by this time farmers had learned the value of Teff-hay for feeding their own stock, and when it did not pay to rail to market, they fed it. Once prices had fallen, I never expected to see them rise again, but increased demand in the towns, and increased local consumption on farms, stimulated by droughty seasons and consequent shortage of winter grazing, have kept the demand above the supply, and good prices are still maintained.

Mr. F. G. Siddle, who formerly farmed near Standerton, claims to have been one of the first to have sent Teff-hay to the Johannesburg market. He has supplied me with the following information : "I think it was in 1906, while farming at Standerton, that amongst other experimental seeds issued by the Government (the



RECORD CROP OF TEFF.

Division of Botany of the Department of Agriculture), I received 5 lbs. of Teff, with instructions to plant 2½ lbs. per acre. I took great care to plant it at that rate, and had a most successful crop, cutting one acre twice; I do not remember at this date, the exact quantity reaped. I found it a most excellent feed, so saved enough seed to put in a much larger acreage the following year, which again proved a success. After selling a quantity to the Standerton Municipality, in 1908, I believe, I forwarded a small truck to Johannesburg market, and expecting that it would be mistaken for "Sweet Grass," I instructed my agents that in the event of not getting a fair offer, to give to some good consumer five bales as a sample and store the remainder. My anticipation proving correct, Mr. Duminy, a large dairyman, took 5 bales on trial, with which he was so satisfied he took the balance. From this time, any I sent to market was well bidden for, and the following season (1909?) it became more common and also in great demand."

By 1910, only seven years after its re-introduction (though twenty-four years after the first seed from Kew had been tried, and failed to establish itself), Teff had become an established crop in the Transvaal. Writing in April, 1911 (19), Mr. J. Wentworth Sykes stated: "Teff has certainly come to stay, as witness the hundreds of tons of hay sold last year on the Johannesburg and Pretoria markets, which is but a tithe of that sold privately or fed locally."

THE WORLD'S RECORD CROP OF TEFF.

Enormous quantities of Teff-hay are daily disposed of on the Johannesburg market, during the season, as much as 150 tons being sold some mornings. The Market Report for the week ending September 2nd, 1916, states: "The feature of the week has been the enormous business in Teff, which amounts to many hundreds of tons."

Fifty to three hundred acres under Teff is now a common sight on most Transvaal farms, and one of my correspondents is arranging to sow 800 acres in the season of 1916-17. But the world's record for Teff-growing on any one farm is held by Mr. W. A. McLaren, of Vereeniging, the well-known South African Manager for Messrs. John Fowler and Co., Steam-plough Manufacturers, of Leeds, England. In the season 1913-14, Mr. McLaren sowed down some twelve hundred acres at Vereeniging, to Teff-grass, for feeding his large herd of cattle.

SUITABILITY FOR OTHER COUNTRIES.

The magnificent success which has attended the introduction of Teff into South Africa satisfies me that it would do equally well in Australia and the Southern United States—if properly handled. Native grasses of South Africa, such as Rhodes-grass and Natal-grass (*Tricholoma rosea*) do so well in many parts of these regions, that it is reasonable to expect Teff would prove equally successful, and it is well worth careful and extended trial.

In 1911, Mr. J. Wentworth Sykes reported having sent "large consignments of seed to all the Provinces of the Union, Rhodesia, Portuguese Territory, and British East Africa." (19.)

In addition to the above localities the present writer has supplied seed to Nyassaland, the British South-West Protectorate, the Belgian Congo, India, Ceylon, Australia, New Zealand, the United States of America, and Argentina.

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